**Psychology 610-27 Neuroimaging Seminar and Lab**
**Fall Semester, 2018**

Class meetings: Instructor: Dr. Hoi-Chung Leung
Tuesday 1 – 4 pm Office: Psych B, Room 314
Psych A, Room 141 Office Hours: By appointment

***Course Description***

This is a multidisciplinary graduate-level course that aims to survey the current advances and issues in the field of human brain imaging. The course will cover several imaging techniques and their applications in studying human behavior and brain function. The course starts by an overview of *in vivo* neuroimaging in animals and humans. It then covers the basics of magnetic resonance imaging (MRI): physics of image formation, resolution limits, physiological basis of fMRI signal, etc. We will discuss statistical, data analysis, and date interpretation issues. Other topics include diffusion and perfusion MRI, pharmacological imaging (e.g., PET), neuromodulation (e.g., TMS), etc. In the lab portion, students will receive training on fMRI experimental design, image acquisition, and image processing and analysis.

***Class Format***

The class will be in the format of seminar style lectures, laboratory exercises and discussions. Students will conduct a group project in the form of a small scale experiment to practice the basic neuroimaging skills.

***Credits***: 0-1: lectures only; 3: lectures and lab (mandatory)

*COURSE PREREQUISITE (optional but preferred): Basic matlab and scripting skills, and introductory or college-level subjects in biopsychology (e.g., Cognitive and Behavioral Neuroscience and Neuroanatomy), probability, linear algebra, differential equations, physiology, chemistry, and physics.*

**COURSE LEARNING OBJECTIVES:**

Obtain a basic understanding of various brain imaging approaches and techniques used for studying human and animal brain function.

*After completing the course, students should be able to:*

- describe the basics of neuroimaging techniques and applications;
- explain the significance, contribution, and application of various neuroimaging techniques in studying brain function and behavior;
- explain the advantages and disadvantages of different imaging methods and their limitations;
- evaluate data acquisition, image quality, and statistical issues;
- conduct various basic image processing steps and analyses;
- formulate a plausible neuroimaging question and design simple experiments;
- complete a simple neuroimaging experiment, conduct corresponding image processing and analysis, and write up reports and present results

***Assignments***

*1. Weekly Readings*

There is no textbook requirement. Weekly readings/videos will be assigned in advance. Please check blackboard frequently for updates (http://blackboard.stonybrook.edu/).

*2. Weekly lab work*

Class members are expected to write short essays, complete lab exercises and write up short reports each week.

*3. Group project*

A group of 2-3 students will design and conduct a simple neuroimaging experiment. It is important to plan ahead and prepare the behavioral task before actual scanning. The final topic needs approval from the course instructor. *Each group will (a) prepare an imaging protocol, (b) formulate and prepare a computerized behavioral task, (c) conduct the short experiment (20-30 minutes total), (d) perform image data processing and analysis, and (e) write up a final report and give a class presentation. See deadlines in the Lab Schedule.*

***Grading:***

Attendance and participation 30%
Lecture essays and lab assignments/reports 40%
Term project report and presentation 30%

*All students should keep in mind that the principle of Academic Honesty requires that this paper be the original work of the student who submits it, and must include appropriate citations for statements and ideas that are the original work of others. If in doubt, cite your sources.*

University Policies:
Americans with Disabilities Act: If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential. Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the following website: http://www.sunysb.edu/ehs/fire/disabilities.shtml.

Academic Integrity: Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

Critical Incident Management: Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn.

**Readings:** *See blackboard posting for weekly reading assignment.*

*(Optional)* Functional Magnetic Resonance Imaging by Scott A. Huettel, Allen W. Song, Gregory McCarthy. 3rd edition. 2014. Sinauer Associates Inc.: Sunderland, MA
(**Required**) NIH fMRI videos https://fmrif.nimh.nih.gov/public/fmri-course/fmri-course-summer-2016

***Class Schedule:*** *(NOTE: This schedule is subject to change. Revisions will be announced in class)*

| Session | Date | Topic | Speaker |
|---|---|---|---|
| Week 1 | 8/28 | Course organization and introduction to neuroimaging | Leung |
| Week 2 | 9/4 | MR contrasts and limits of spatial & temporal resolution *(NIH video #2)* | Leung |
| Week 3 | 9/11 | fMRI paradigms and designs *(NIH video #3 by Bandettini)* | Leung |
| Week 4 | 9/18 | What fMRI can and cannot do; *what is neural and what is not* | Leung |
| Week 5 | 9/25 | Pharmacological imaging: Current advances in PET | Slifstein |
| Week 6 | 10/2 | Sample size and big data issues | Leung |
| | 10/9 | No Class – Fall break | |
| Week 7 | 10/16 | Statistics of fMRI and thresholding *(NIH video #24)* | Leung |
| Week 8 | 10/23 | Functional connectivity and resting State fMRI *(NIH videos #6, #9)* | Leung |
| Week 9 | 10/30 | Diffusion MRI | Leung |
| Week 10 | 11/6 | SCAN Center: equipment and image acquisition | |
| Week 11 | 11/13 | Brain reading with fMRI – classification *(NIH video #16 & 14)* | Leung |
| Week 12 | 11/20 | Neurovascular coupling (including Perfusion MRI - ASL) | Xiang He |
| Week 13 | 11/27 | ***Neuroimaging: animal models*** | *Duong* |
| Week 14 | 12/4 | The future of fMRI in cognitive neuroscience *(NITP video by Poldrack)* | |

*Readings and Supplementary Materials are on blackboard.*

*(Lab schedule on the next page)*

***Lab schedule:*** *(NOTE: This schedule is subject to change. Revisions will be announced in class)*

| Session | Date | Task | Notes |
|---|---|---|---|
| Week 1 | 8/28 | *Slides:* A history of neuroimaging<br>Introduction to Unix, Matlab and PsychoPy (see primers & online resources) | *NIH video #1 by Bandettini* |
| Week 2 | 9/4 | *Slides:* MRI and fMRI basics and data acquisition<br>*Lab*: Examine MR images: T1, T2, EPI; identify some brain structures<br>*tools: AFNI interactive, MRIcron, Atlases (MNI vs Talairach, michigan state, Mai Brain Navigator)*<br>***Group work****: Topic selection* | *youtube* |
| Week 3 | 9/11 | *Slides:* MRI and fMRI basics and data acquisition (*continue)*<br>*Lab*: View more brain images (from different age and disease state)<br>*Imaging Protocol:* picking parameters and tradeoffs<br>***Group work***: *Submit research question on Blackboard* | *NIH video #4* |
| Week 4 | 9/18 | *Slides: NMR protocol and preprocessing steps*<br>*Lab*: Image preprocessing (SPM/AFNI), motion correction & artifact issues Evaluate and discuss image quality and processing issue<br>*tools: AFNI, SPM (with ART), MRIcron*<br>***Group work***: *Project planning (define variables and parameters)* | |
| Week 5 | 9/25 | *Lab:* Registration, segmentation & labeling<br>*tools: SPM (CAT12, DARTEL)/FSL, freesurfer, mindboggle*<br>***Group work****: Project planning (finalize protocol) and share and evaluate each other's study design*<br>***Submit a draft of your group's study design and NMR protocol*** | |
| Week 6 | 10/2 | *Lab*: Single subject analysis & General Linear Model<br>*tools*: SPM or AFNI<br>***Group work:*** *Task programming* | *SPM video* |
| Week 7 | 10/16 | *Lab*: Second level analysis (use SPM or AFNI sample datasets)<br>*tools*: SPM or AFNI<br>***Group work***: *Finish task programming and show the instructor* | *SPM video (advance methods)* |
| Week 8 | 10/23 | *Lab*: Functional connectivity: rsFC and PPI; examine various networks (e.g., frontoparietal, motor, sensory, DMN)<br>*tools*: HCP, AFNI's INSTACOR (discuss head motion issues and artifact control in this context)<br>***Submit final design report, MRI protocol and computerized task*** | *NIH video #6 by Chang* |
| Week 9 | 10/30 | *Slides: What you can and cannot do with diffusion MRI*<br>*Lab*: DTI preprocessing and tracking<br>*tools*: TORTOISE | *NIH video #36 by Pierpaoli* |
| Week 10 | 11/6 | SCAN center - Data Collection!! Note that we are meeting on Monday. | |
| Week 11 | 11/13 | *Lab*: overview of advance fMRI statistics: MVPA, DCM, ICA, network<br>*Self-serve lab: Work on your project* | |
| Week 12 | 11/20 | *Self-serve lab*: *Work on your project (aim to complete data analysis)* | |
| Week 13 | 11/27 | Discuss neuroethics and application of fMRI<br>*Self-serve lab*: ***Finish data analysis and write up final lab report*** | |
| Week 14 | 12/4 | Student project presentations | |